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**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**
**BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES**

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| Application of: | Carlos Dangelo | Confirmation No.: | 5164 |
| Serial No.: | 10/762,666 | Art Unit: | 2811 |
| Filed: | January 22, 2004 | Examiner: | Nitin, Parekh |
| For: | *Method and Apparatus for the Use of Self-Assembled Nanowires for the Removal of Heat from Integrated Circuits* | Attorney Docket No.: | 062273-5001-US |
| | | Date: | February 14, 2007 |

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Commissioner for Patents
Arlington, VA 22202

**APPELLANTS' BRIEF UNDER 37 C.F.R. § 41.37**

This brief follows a Notice of Appeal filed November 16, 2006 and appeals the rejections of claims 28-32 under 35 U.S.C. §103(a) by the United States Patent and Trademark Office in a Office Action dated July 17, 2006. This Appeal Brief demonstrates that such rejections cannot be sustained because: (1) the references do not enable the claimed invention, (2) the proposed modification of the primary reference would change its principle of operation, and (3) there is no motivation to combine the references.

The fee required under 37 C.F.R. § 41.20(b)(2) is estimated to be $250. Please charge the required fee to Morgan, Lewis & Bockius LLP Deposit Account No. 50-0310 (order no. 62273-5001-US). A copy of this sheet is enclosed.

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## 1. THE REAL PARTY IN INTEREST

The real party in interest in this appeal is Nanoconduction, Inc., the assignee of this application.

## 2. RELATED APPEALS AND INTERFERENCES

Appellant and appellant's legal representative are not aware of any appeals, interferences, or judicial proceedings that will affect directly, will be affected directly by, or will otherwise have a bearing on, the decision in this appeal.

## 3. STATUS OF THE CLAIMS

The status of the claims is as follows:

Claims canceled: 22-27.

Claims withdrawn from consideration but not canceled: 1-21.

Claims pending: 28-32.

Claims rejected: 28-32.

Claims appealed: 28-32.

## 4. STATUS OF AMENDMENTS

A request for continued examination (RCE) under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Because this application was eligible for continued examination under 37 CFR 1.114, and the fee was timely paid, the finality of the office action was withdrawn pursuant to 37 CFR 1.114. Applicant's Response to Final Office Action, filed on June 15, 2006, was entered. An action on the RCE followed, which rejected claims 28-32.

A copy of the rejected claims is attached as Appendix A.

## 5. SUMMARY OF CLAIMED SUBJECT MATTER

As the speed and density of modern integrated circuits increase, the power generated by these chips also increases. (*Application*, p. 1, lines 20-21.) The ability to dissipate the heat being generated by current ICs is becoming a serious limitation in the advance of technology. (*Application*, p. 1, lines 22-24.) While some aspects of this problem can be mitigated by forced convection devices such as fans (and even liquid cooling), the core of the problem is now shifting to the thermal resistances within the chip itself. (*Application*, p. 1, lines 24-26.) This problem is producing high junction temperatures which directly affect chip reliabilities. (*Application*, p. 2, lines 2-3.) The present Application addresses this in-chip heat removal problem.

The Application's claims are directed toward an integrated circuit die having enhanced power dissipation. The integrated circuit die includes one or more cavities in the backside of the die that contain a heat conductive media with a thermal conductivity greater than the bulk thermal conductivity of the substrate. The heat conductive media may include copper (Claim 28) or carbon nanotubes (Claims 29-32).

### A. Independent Claim 28: An integrated circuit die having enhanced power dissipation

The integrated circuit die of claim 28 includes a substrate. (*Application*, p. 5, line 2; p. 11, line 3-5; Figure 4, substrate 416.) The substrate has a top surface upon which power generating devices of the integrated circuit die are fabricated. (*Application*, p. 5, lines 2-3; p. 11, line 11; Figure 4, CMOS transistors with gates 408.) The substrate has a backside surface essentially parallel to said top surface. (*Application*, p. 5, lines 3-4; p. 11, line 5; Figure 4, back surface 414.)

The integrated circuit die of claim 28 also includes at least one cavity. (*Application*, p. 5, line 5; p. 11, lines 4-5 and lines 14-17; Figure 4, cavity 412.) The cavity extends from the backside surface a predetermined distance toward the top surface. (*Application*, p. 5, lines 5-6; Figure 4, cavity 412.) The predetermined distance is less than the distance between the top surface and the backside surface. (*Application*, p. 5, lines 6-7; Figure 4, cavity 412.)

The integrated circuit die of claim 28 also includes a heat conductive media contained within the at least one cavity. (*Application*, p. 5, lines 7-8; p. 11, lines 8-9; Figure 4, carbon nanotube filled heat conduction structures 402; Figure 5, carbon nanotubes 502.) The media has a thermal conductivity greater than a bulk thermal conductivity of the substrate, such that heat produced by the power generating devices is transferred to the backside surface via the heat conductive media. (*Application*, p. 5, lines 8-10.) The heat conducting media comprises copper. (*Application*, p. 9, lines 12-13; *Application*, p. 11, lines 8-9.)

**B. <u>Independent Claim 29: An integrated circuit die having enhanced power dissipation</u>**

The integrated circuit die of claim 29 includes a substrate. (*Application*, p. 5, line 2; p. 11, line 3-5; Figure 4, substrate 416.) The substrate has a top surface upon which power generating devices of the integrated circuit die are fabricated. (*Application*, p. 5, lines 2-3; p. 11, line 11; Figure 4, CMOS transistors with gates 408.) The substrate has a backside surface essentially parallel to said top surface. (*Application*, p. 5, lines 3-4; p. 11, line 5; Figure 4, back surface 414.)

The integrated circuit die of claim 29 also includes at least one cavity. (*Application*, p. 5, line 5; p. 11, lines 4-5 and lines 14-17; Figure 4, cavity 412.) The cavity extends from the backside surface a predetermined distance toward the top surface. (*Application*, p. 5, lines 5-6;

Figure 4, cavity 412.) The predetermined distance is less than the distance between the top surface and the backside surface. (*Application*, p. 5, lines 6-7; Figure 4, cavity 412.)

The integrated circuit die of claim 29 also includes a heat conductive media contained within the at least one cavity. (*Application*, p. 5, lines 7-8; p. 11, lines 8-9; Figure 4, carbon nanotube filled heat conduction structures 402; Figure 5, carbon nanotubes 502.) The media has a thermal conductivity greater than a bulk thermal conductivity of the substrate, such that heat produced by the power generating devices is transferred to the backside surface via the heat conductive media. (*Application*, p. 5, lines 8-10.) The heat conducting media comprises carbon nanotubes. (*Application*, p. 9, lines 11-15; *Application*, p. 11, lines 8-9 and line 15; Figure 4, carbon nanotube filled heat conduction structures 402; Figure 5, carbon nanotubes 502.)

## 6. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

In the Office Action mailed July 17, 2006, the Examiner rejected claims 28-32 under 35 U.S.C. 103(a). In particular, the Examiner:

A. Rejected claim 28 under 35 U.S.C. 103(a) as being unpatentable over Dahl et al. (US Pat. Application Pub. 2002/0130407) in view of Cromwell (US Pat. 5,926,370); and

B. Rejected claims 29-32 under 35 U.S.C. 103(a) as being unpatentable over Dahl et al. (US Pat. Application Pub. 2002/0130407) in view of Montgomery et al. (US Pat. Application Pub. 2003/0117770)

## 7. ARGUMENTS

In response, Appellant submits that the rejections cannot be sustained because: (1) the references do not enable the claimed invention, (2) the proposed modification of the primary reference would change its principle of operation, and (3) there is no motivation to combine the references. Each of these points is addressed below.

### A. Rejection of claim 28 under 35 U.S.C. 103(a) as being unpatentable over Dahl et al. (US Pat. Application Pub. 2002/0130407) in view of Cromwell (US Pat. 5,926,370)

**1. The references do not enable a person of ordinary skill to make and use the claimed invention.**

Federal Circuit case law expressly requires that the prior art must enable a person of ordinary skill to make and use the claimed invention in order to render the claimed invention unpatentable for obviousness:

> Although published subject matter is "prior art" for all that it discloses, in order to render an invention unpatentable for obviousness, the prior art must enable a person of ordinary skill to make and use the invention.

*In re Kumar*, 418 F.3d 1361, 1368 (Fed. Cir. 2005), citing *Beckman Instruments, Inc. v. LKB Produkter AB*, 892 F.2d 1547, 1551 (Fed. Cir.1989), emphasis added. This enablement requirement applies to both method claims and apparatus claims:

> In order to render a claimed apparatus or method obvious, the prior art must enable one skilled in the art to make and use the apparatus or method.

*Beckman Instruments* 892 F.2d at 1551, citing *In re Payne*, 606 F.2d 303, 314, (CCPA 1979), emphasis added.

Thus, to render Claim 28 unpatentable for obviousness, Dahl and/or Cromwell must enable a person of ordinary skill to make an integrated circuit die with at least one cavity

extending from the backside surface of the die a predetermined distance toward the top surface of the die, wherein the cavity contains a heat conductive media comprising copper.

First, consider what enablement, if any, Cromwell provides for making the integrated circuit die of Claim 28. Cromwell discloses "a modular integrated apparatus that combines a CPU, a power converter, the associated power cables, and a printed circuit board into a system package that also functions as an EMI containment enclosure and a heat management device" (Cromwell, Field of the Invention). Note that the "heat management device" in Cromwell is not an integrated circuit die. Indeed, Cromwell discloses conventional, macroscopic heat pipes "made of copper" that "contain water that undergoes a phase change when the evaporating end of the heat pipes is heated." (Cromwell, Col. 10, lines 22-24) Such conventional, phase-change-cooled heat pipes are not part of an integrated circuit die and, as discussed in the next section, are far too large to be incorporated in an integrated circuit die. Thus, Cromwell teaches nothing about how to make the integrated circuit die of Claim 28.

Next, consider what enablement, if any, Dahl provides for making the integrated circuit die of Claim 28. Dahl discloses "[n]ovel uses of diamondoid-containing materials in the field of microelectronics" (Dahl, abstract). Copper is not a diamondoid-containing material. The only portions of Dahl that are relevant to the integrated circuit die of Claim 28 are Fig. 6C and paragraph [0121], in which Dahl discloses that diamondoid-containing "heat pipes or heat conduits 631, 632 may be used to conduct heat away from the chip to a heat sink located remotely from the package" (Dahl, paragraph [0121]).

Dahl's entire teachings concerning diamondoid-containing heat conduits are contained in paragraph [0121], which states:

> In this embodiment, heat pipes or heat conduits 631, 632 may be used to conduct heat away from the chip to a heat sink located remotely from the package. The

> heat conduits may be in fiber form, and may be inserted into the integrated circuit chip itself at locations 633, 634, or they may communicate with thermal vias (not shown) within the chip. The heat conducting conduits may be flexible fibers, or rigid rods. There may be from about 1 to 100 of the heat conducting fibers or rods.

There is no teaching in paragraph [0121] or elsewhere in Dahl of: (1) how to make copper (or even diamondoid) conduits in fiber form (either rigid or flexible) or any other form; (2) how to insert from about 1 to 100 copper (or even diamondoid) conduits into the chip; or (3) how copper (or even diamondoid) conduits would "communicate" with thermal vias (not shown). Thus, Dahl must necessarily fail to enable one of ordinary skill in the art to make an integrated circuit die with at least one cavity extending from the backside surface of the die a predetermined distance toward the top surface of the die, wherein the cavity contains a heat conductive media comprising copper, as required by Claim 28.

As discussed above, Cromwell fails to provide the enablement that is missing in Dahl because Cromwell's teachings concern conventional, macroscopic heat pipes. Cromwell teaches nothing about how to make copper heat conduits in integrated circuit dies. Miniaturizing the conventional, macroscopic copper heat pipes of Cromwell to fit within an integrated circuit die is not taught by Cromwell or Dahl, and how to accomplish such miniaturizing would not be at all obvious from these references.

Thus, Dahl and/or Cromwell fail to enable one of skill in the art to make a heat conductive media comprising copper contained within at least one cavity extending from the backside surface of an integrated circuit substrate. Because Dahl and Cromwell fail to enable claim 28, Dahl and Cromwell also fail to make claim 28 obvious.

In the office action dated April 27, 2006 at paragraph 4.C on p. 7, the Examiner states:

> Applicant contends that there is no teaching in Dahl et al. of how to make copper conduits, how to make copper conduits in fiber/rigid/flexible form, or

> how to insert from about 1 to 100 copper conduits into the chip; or how to communicate with thermal vias.
>
> However, as explained in the rejections above, Cromwell is combined with Dahl to provide the missing elements in Dahl et al's power/heat dissipation structure. Furthermore, the claims under examination are directed to the device and not a method of making such device. (emphasis added)

The Applicant respectfully disagrees with the Examiner's April 27, 2006 analysis, for the following reasons. As explained above, "to render an invention unpatentable for obviousness, the prior art must enable a person of ordinary skill to make and use the invention." *In re Kumar*, 418 F.3d at 1368, emphasis added. This statement of law applies to claims directed to a device, not just to claims directed to a method of making the device. *Beckman Instruments* 892 F.2d at 1551. For claim 28, Dahl and/or Cromwell must enable a person of ordinary skill to make and use the claimed integrated circuit die.

This first reason is not concerned with 'missing elements.' Rather, this first reason is concerned with 'missing enablement.' Even assuming for the sake of argument that Dahl and Cromwell disclose a heat conductive media comprising copper that is contained within at least one cavity extending from the backside surface of an integrated circuit substrate (an incorrect assumption), Dahl and/or Cromwell fail to enable one of skill in the art to make such a structure, as explained above.

In the office action dated July 17, 2006 at paragraph 5.C on p. 7, the Examiner states:

> Applicant contends that Dahl et al. and/or Cromwell fail to enable or teach in the structure: 1) how to make copper conduits in fiber form; 2) how to insert from about 1 to 100 copper conduits into the chip; or 3) how to communicate with thermal vias.
>
> However, the references are not necessarily applied for such limitations.

The Applicant respectfully disagrees with the Examiner's July 17, 2006 analysis, for the following reasons. As explained above, there is no teaching in paragraph [0121] or elsewhere in

Dahl of: (1) how to make copper conduits in fiber form (either rigid or flexible) or any other form; (2) how to insert from about 1 to 100 copper conduits into the chip; or (3) how to "communicate" with thermal vias (not shown). The Examiner does not dispute the lack of these teachings in Dahl. The Examiner apparently fails to understand, however, that the lack of these teachings means that Dahl must necessarily fail to enable one of ordinary skill in the art to make an integrated circuit die with at least one cavity extending from the backside surface of the die a predetermined distance toward the top surface of the die, wherein the cavity contains a heat conductive media comprising copper, as required by Claim 28. Moreover, Cromwell fails to provide the enablement that is missing in Dahl because Cromwell teaches nothing about how to make copper heat conduits in integrated circuit dies. Because Dahl and/or Cromwell fail to enable claim 28, Dahl and Cromwell also fail to make claim 28 obvious.

**2. The proposed modification of Dahl by Cromwell would change the principle of operation of Dahl**

The Manual of Patent Examining Procedure (MPEP) expressly provides that prior art references do not render a claimed invention prima facie obvious if the combination of references would change the principle of operation of the primary reference:

> If the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims prima facie obvious.

MPEP 2413.01, citing *In re Ratti*, 270 F.2d 810 (CCPA 1959) (Court found "suggested combination of references would require a substantial reconstruction and redesign of the elements shown in [the primary reference] as well as a change in the basic principle under which the [primary reference] construction was designed to operate." 270 F.2d at 813.).

Cromwell discloses conventional, macroscopic heat pipes "made of copper" that "contain water that undergoes a phase change when the evaporating end of the heat pipes is heated." (Cromwell, Col. 10, lines 22-24) Such conventional, phase-change-cooled heat pipes are far too large to be incorporated in an integrated circuit die. In addition, the suggested combination of Dahl with Cromwell would require Dahl to incorporate conventional, phase-change-cooled heat pipes. The suggested combination would require a substantial reconstruction and redesign of the elements shown in Dahl. In addition, the basic principle under which Dahl was designed to operate would have to be changed from solid-state heat conduction to phase-change cooling.

Thus, because the combination of Dahl with Cromwell would change the principle of operation of Dahl, the Dahl and Cromwell references do not establish a prima facie case for obviousness.

**3. There is no motivation to combine the references**

It is well established that "[o]bviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is some teaching, suggestion, or motivation to do so. *See, In re Kahn*, 441 F.3d 977, 986 (Fed. Cir. 2006) and MPEP §2143.01. The motivation to modify or combine the prior art references must be found in the teachings of the prior art, the knowledge of persons of ordinary skill in the art, or the nature of the problem to be solved. *See, In re Rouffet*, 149 F.3d 1350 (Fed. Cir. 1998). Combining references without evidence of such a motivation is impermissible hindsight. *See, In re Dembiczak*, 175 F.3d 994, 999 (Fed. Cir. 1999) (abrogated on other grounds by *In re Gartside*, 203 F.3d 1305, 1316 (Fed. Cir. 2000)). The Examiner and the Board must specifically identify the reasons one skilled in the art would combine the cited prior art references. *See, In re Rouffet*, 149 F.3d at 1359. The inventor's teachings may not be used to reject the inventor's claims in the

same patent application. *See, In re Dembiczk,* 175 F.3d at 999. The evidence showing a motivation to combine the prior art references must be "clear and particular." *Id.*

In the office action mailed August 30, 2005, the following motivation to combine Dahl with Cromwell was given:

> It would have been obvious to a person of ordinary skill in the art at the time [the] invention was made to incorporate the HCM comprising copper as taught by Cromwell so that fabrication and processing can be simplified in Dahl et al's IC cooling structure. (emphasis added)

As noted in the Applicant's February 8, 2006 Amendment, Cromwell's conventional heat pipes are too large to be incorporated in an integrated circuit die. Thus, contrary to the stated motivation to combine Dahl with Cromwell, fabrication and processing would not be simplified by incorporating Cromwell's conventional heat pipes in Dahl et al's IC cooling structure.

In the office action mailed April 27, 2006 on p. 3, a new motivation to combine Dahl with Cromwell was given, which comprised a single, conclusory sentence:

> It would have been obvious to a person of ordinary skill in the art at the time [the] invention was made to incorporate the HCM comprising copper as taught by Cromwell as an obvious alternative serving the purpose of heat management/dissipation in Dahl et al's IC cooling structure. (emphasis added)

In the office action mailed July 17, 2006 on p. 4, the Examiner repeated the same motivation to combine Dahl with Cromwell as the Examiner gave in the office action mailed April 27, 2006.

It is respectfully submitted that a conclusory 'It's obvious because its an obvious alternative' statement is impermissible hindsight that does not adequately address the issue of motivation to combine. As stated in *In re Sang Su Lee*, 277 F.3d 1338, 61 USPQ2d 1430 (Fed. Cir. 2002):

> The factual inquiry whether to combine references must be thorough and searching." [*McGinley v. Franklin Sports, Inc.*, 262 F.3d 1339, 1351-52, 60 USPQ2d 1001, 1008 (Fed. Cir. 2001)] It must be based on objective evidence of record. This precedent has been reinforced in myriad decisions, and cannot be dispensed with. See, e.g., *Brown & Williamson Tobacco Corp. v. Philip Morris Inc.*, 229 F.3d 1120, 1124-25, 56 USPQ2d 1456, 1459 (Fed. Cir. 2000) ("a

> showing of a suggestion, teaching, or motivation to combine the prior art references is an 'essential component of an obviousness holding'") (quoting *C.R. Bard, Inc., v. M3 Systems, Inc.*, 157 F.3d 1340, 1352, 48 USPQ2d 1225, 1232 (Fed. Cir. 1998)); *In re Dembiczak*, 175 F.3d 994, 999, 50 USPQ2d 1614, 1617 (Fed. Cir. 1999) ("Our case law makes clear that the best defense against the subtle but powerful attraction of a hindsight-based obviousness analysis is rigorous application of the requirement for a showing of the teaching or motivation to combine prior art references.")

Thus, claim 28 is patentable over Dahl and Cromwell for at least the reasons stated above.

**B. Rejection of claims 29-32 under 35 U.S.C. 103(a) as being unpatentable over Dahl et al. (US Pat. Application Pub. 2002/0130407) in view of Montgomery et al. (US Pat. Application Pub. 2003/0117770)**

**1. The references do not enable a person of ordinary skill to make and use the claimed invention.**

As noted above, Federal Circuit case law expressly requires that the prior art must enable a person of ordinary skill to make and use the claimed invention in order to render the claimed invention unpatentable for obviousness:

> Although published subject matter is "prior art" for all that it discloses, in order to render an invention unpatentable for obviousness, the prior art must enable a person of ordinary skill to make and use the invention.

*In re Kumar*, 418 F.3d 1361, 1368 (Fed. Cir. 2005), citing *Beckman Instruments, Inc. v. LKB Produkter AB*, 892 F.2d 1547, 1551 (Fed. Cir.1989), emphasis added. This enablement requirement applies to both method claims and apparatus claims:

> In order to render a claimed apparatus or method obvious, the prior art must enable one skilled in the art to make and use the apparatus or method.

*Beckman Instruments* 892 F.2d at 1551, citing *In re Payne*, 606 F.2d 303, 314, (CCPA 1979), emphasis added.

Thus, to render Claim 29 unpatentable for obviousness, Dahl and/or Montgomery must enable a person of ordinary skill to make an integrated circuit die with at least one cavity

extending from the backside surface of the die a predetermined distance toward the top surface of the die, wherein the cavity contains a heat conductive media comprising carbon nanotubes.

First, consider what enablement, if any, Dahl provides for making the integrated circuit die of Claim 29. Dahl discloses "[n]ovel uses of diamondoid-containing materials in the field of microelectronics" (Dahl, abstract). Carbon nanotubes are not a diamondoid-containing material. The only portions of Dahl that are relevant to the integrated circuit die of Claim 29 are Fig. 6C and paragraph [0121], in which Dahl discloses that diamondoid-containing "heat pipes or heat conduits 631, 632 may be used to conduct heat away from the chip to a heat sink located remotely from the package" (Dahl, paragraph [0121]).

Dahl's entire teachings concerning diamondoid-containing heat conduits are contained in paragraph [0121], which states:

> In this embodiment, heat pipes or heat conduits 631, 632 may be used to conduct heat away from the chip to a heat sink located remotely from the package. The heat conduits may be in fiber form, and may be inserted into the integrated circuit chip itself at locations 633, 634, or they may communicate with thermal vias (not shown) within the chip. The heat conducting conduits may be flexible fibers, or rigid rods. There may be from about 1 to 100 of the heat conducting fibers or rods.

There is no teaching in paragraph [0121] or elsewhere in Dahl of: (1) how to make carbon nanotube (or even diamondoid) conduits in fiber form (either rigid or flexible) or any other form; (2) how to insert from about 1 to 100 carbon nanotube (or even diamondoid) conduits into the chip; or (3) how carbon nanotube (or even diamondoid) conduits would "communicate" with thermal vias (not shown). Thus, Dahl must necessarily fail to enable one of ordinary skill in the art to make an integrated circuit die with at least one cavity extending from the backside surface of the die a predetermined distance toward the top surface of the die, wherein the cavity contains a heat conductive media comprising carbon nanotubes, as required by Claim 29.

Montgomery fails to provide the enablement that is missing in Dahl because Montgomery's teachings concern making carbon nanotube structures external to an integrated circuit die that make contact with the die (e.g., carbon nanotube bundles 26, which were previously grown on substrate 28, make contact with die 12 in Fig. 4 of Montgomery). Montgomery teaches nothing about how to make carbon nanotube heat conduits inside integrated circuit dies.

Thus, Dahl and/or Montgomery fail to enable one of skill in the art to make a heat conductive media comprising carbon nanotubes contained within at least one cavity extending from the backside surface of an integrated circuit substrate. Because Dahl and Montgomery fail to enable claim 29, Dahl and Montgomery also fail to make claim 29 obvious.

In the office action dated April 27, 2006, the Examiner did not respond to Applicant's argument that Dahl and Montgomery fail to enable claim 29.

In the office action dated July 17, 2006 at paragraph 5.E on p. 7, the Examiner states:

> Applicant contends that Dahl et al. and/or Montgomery et al. fail to enable or teach in the structure: 1) how to make carbon nanotubes conduits in fiber form; 2) how to insert from about 1 to 100 carbon nanotubes conduits into the chip; or 3) how to communicate with thermal vias.
>
> However, the references are not necessarily applied for such limitations.

The Applicant respectfully disagrees with the Examiner's July 17, 2006 analysis, for the following reasons. As explained above, there is no teaching in paragraph [0121] or elsewhere in Dahl of: (1) how to make carbon nanotube conduits in fiber form (either rigid or flexible) or any other form; (2) how to insert from about 1 to 100 carbon nanotube conduits into the chip; or (3) how to "communicate" with thermal vias (not shown). The Examiner does not dispute the lack of these teachings in Dahl. The Examiner apparently fails to understand, however, that the lack of these teachings means that Dahl must necessarily fail to enable one of ordinary skill in the art to

make an integrated circuit die with at least one cavity extending from the backside surface of the die a predetermined distance toward the top surface of the die, wherein the cavity contains a heat conductive media comprising carbon nanotubes, as required by Claim 29. Moreover, Montgomery fails to provide the enablement that is missing in Dahl because Montgomery's teachings concern making carbon nanotube structures external to an integrated circuit die that make contact with the die. Montgomery teaches nothing about how to make carbon nanotube heat conduits inside integrated circuit dies. Because Dahl and/or Montgomery fail to enable claim 29, Dahl and Montgomery also fail to make claim 29 obvious.

Because claim 29 is not made obvious by Dahl and Montgomery et al., dependent claims 30-32 are also not made obvious by Dahl and Montgomery et al.

## 8. APPENDICES

APPENDIX A provides appealed claims ordered by number.

APPENDIX B provides copies of evidence entered in the record and relied upon.

APPENDIX C provides copies of decisions rendered by the Board or a court in any related proceeding.

## CONCLUSION

Appellants submit that the reasons for the Examiner's rejections under 35 U.S.C. §103(a) cannot be sustained because: (1) the references do not enable the claimed invention, (2) the proposed modification of the primary reference would change its principle of operation, and (3) there is no motivation to combine the references. In view of the foregoing, Appellants respectfully request the reversal of the Examiner's rejections and allowance of the pending claims 28-32.

If there are any additional fees due in connection with the filing of this Brief, please charge them to Morgan, Lewis & Bockius LLP Deposit Account No. 50-0310 (order no. 62273-5001-US).

Respectfully submitted,

Date: February 14, 2007

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## APPENDIX A - CLAIMS

## CLAIMS CURRENTLY ON APPEAL ORDERED BY NUMBER

28. (Previously presented): An integrated circuit die having enhanced power dissipation, comprising:

a substrate, having a top surface upon which power generating devices of said integrated circuit die are fabricated, said substrate having a backside surface essentially parallel to said top surface;

at least one cavity, extending from said backside surface a predetermined distance toward said top surface, said predetermined distance being less than the distance between said top surface and said backside surface; and

a heat conductive media contained within said at least one cavity, said media having a thermal conductivity greater than a bulk thermal conductivity of said substrate, such that heat produced by said power generating devices is transferred to the backside surface via said heat conductive media, wherein said heat conducting media comprises copper.

29. (Previously presented): An integrated circuit die having enhanced power dissipation, comprising:

a substrate, having a top surface upon which power generating devices of said integrated circuit die are fabricated, said substrate having a backside surface essentially parallel to said top surface;

at least one cavity, extending from said backside surface a predetermined distance toward said top surface, said predetermined distance being less than the distance between said top surface and said backside surface; and

a heat conductive media contained within said at least one cavity, said media having a thermal conductivity greater than a bulk thermal conductivity of said substrate, such that heat produced by said power generating devices is transferred to the backside surface via said heat conductive media, wherein said heat conducting media comprises carbon nanotubes.

30. (Previously presented): An integrated circuit die having enhanced power dissipation as recited in claim 29, wherein said at least one cavity is located directly below at least one power generating device in said substrate.

31. (Original): An integrated circuit die having enhanced power dissipation as recited in claim 30, wherein said at least one power generating device is a transistor having a drain, said at least one cavity being located directly below said drain.

32. (Original): An integrated circuit die having enhanced power dissipation as recited in claim 30, wherein said at least one power generating device is a transistor having a source, said at least one cavity being located directly below said source.

## APPENDIX B – EVIDENCE

1. U.S. Patent Application Publication No. 2002/0130407 by Dahl *et al.*, published on September 19, 2002

2. U.S. Patent No. 5,926,370 issued to Cromwell on July 20, 1999

3. U.S. Patent Application Publication No. 2003/0117770 by Montgomery *et al.*, published on June 26, 2003.

4. U.S. Application Serial No. 10/762,666

5. [Second] Office Action dated August 30, 2005.

6. Response to [Second] Office Action dated February 8, 2006.

7. Final Office Action dated April 27, 2006.

8. Response to Final Office Action dated June 15, 2006.

9. Office Action dated July 17, 2006.

## APPENDIX C – RELATED PROCEEDINGS

None.